SUMMARY

(1) The incidence of the *in vivo* development of streptomycin resistance is reported in 88 cases treated by 1 gm. of streptomycin daily in divided doses for periods of 60 to 90 days. (2) attention is drawn to the following points: (*a*) the possible advantage of a solid medium whereby some indication may be obtained of the relative number of resistant and sensitive variants. (*b*) The high incidence of streptomycin sensitive strains encountered prior to therapy. (*c*) The possible delay in the appearance of streptomycin resistant variants even after the conclusion of therapy. (*d*) The absence of a return, even after several months, to a sensitive state. (*e*) The relative early onset of resistance. (*f*) Possible discrepancies in reported results depending on the methods employed.

The authors wish to indicate their indebtedness to Professor P. Greey for his constant advice and guidance, and to Miss C. Daniels and Miss E. Whitcher for their meticulous attention to records. Permission to publish the note was obtained through the courtesy of Dr. C. A. Wicks, Superintendent, Toronto Hospital for Tuberculosis, Weston, Ontario. We also acknowledge the financial aid given in these projects by the Ontario Department of Health through the Federal Health grants.

EXTRA-PERITONEAL, END-TO-END SUTURE OF THE FEMORAL NERVE*

Campbell Gardner, F.R.C.S.[C.], and Harold Elliott, M.D

Montreal, Que.

FEMORAL nerve lesions are rare and few have been recorded.

Pollock and Davis[1] in their excellent treatise noted that injuries to the femoral nerve in World War I occurred in less than 1 to 2% of the cases studied. In an analysis by Stookey[2] of the frequency of nerve injuries of the lower extremity the femoral (anterior crural) nerve was injured less commonly than sciatic, peroneal and tibial (in that order) but more commonly than anterior tibial, lumbar plexus, small sciatic and musculocutaneous. Benisty[3] confined his discussion to the effect of a projectile traversing femoral branches below the inguinal ligament. Gurdjian[4] reported in 1931 suture of an almost-completely-divided nerve, originally caused by incision and drainage of an extensive inguinal abscess. This patient's progress seven months after operation was suggestive of recovery. Haymaker and Woodhall[5] dealing with World War II injuries note that femoral nerve trunk injuries were seldom "seen clinically since wounds in this region by lacerating blood vessels tend to be fatal". Sutures have been done on the femoral trunk in certain peripheral nerve centres in Great Britain but the results had not been published when this study was first presented to the Montreal Neurological Society in January, 1947.

In our series of over 500 nerve injuries, we have had only three examples of femoral nerve injury. Two were incomplete and in this third example, end to end suture was obtained by the method described.

Since the mortality rate from missile wounds of the abdomen has been improved in World War II, complete femoral nerve lesions which usually have an associated abdominal wound, are likely to be more common than following World War I.

The same principles hold for suture of the femoral nerve, even though its course is mainly intra-pelvic, that apply to any peripheral nerve. There should be early recognition; there must be adequate exposure; mobilization will often overcome great gaps; flexion of joints should be utilized; proper nerve pattern must be obtained; and with care the vast majority of nerve lesions can be repaired by end-to-end suture.

Because of the short distance to the quadriceps (the down-growing neurofibrils of the femoral nerve have approximately 12 cm. to travel),* and since the long, flat, coarse muscles of the quadriceps group are to be innervated, fair prognosis can be given, even though sutured late. This communication has been withheld during the period of follow-up. The patient noted improvement in sensation at eight months, and returning power in the quadriceps at ten months after injury.

CASE REPORT

Pte. D.E., wounded on October 6, 1944. The missile entered the left hip, fractured the crest of the ilium, and emerged in the right lower abdomen (passing onwards and fracturing the patient's right thumb). Three holes in the small bowel were closed in No. 8 Field Surgical Unit and a lacerated sigmoid colon was exteriorized as a double barrelled colostomy. On November 6, 1944, secondary suture of the multiple wounds of the right thigh was carried out. On December 27, 1944, the colostomy wound was clamped, and was closed three months after injury. Bowel movements were reported as normal on January 26, 1945.

His description of the moment of injury was as follows: "My left leg buckled up and I couldn't get it down and couldn't figure out why it wouldn't go down. I was standing with my Bren gun between a hedge and a field and we were being overtaken by the Germans. On being hit I felt a burning sensation in my hip and stomach. I twisted and fell and my whole body seemed to be paralyzed but this may have been because I was dead tired. I was unable to crawl to a slit trench where my officer was ordering us. Pretty soon I was able to move my wounded thumb and put it into my tunic. Be-

* From the Services of Surgery, and Neurosurgery, Queen Mary Veterans' Hospital and Montreal General Hospital, McGill University.

* H. Owen in the pathological laboratory of the Montreal General Hospital did several dissections to prove this point. It depends on the situation of the junction to form the femoral nerve trunk.

cause of my buckled knee I then had to lie on my right side.''*

The wound in the left iliac region broke down several times, discharging purulent material in February, April and June, 1945. On June 9, a sinus in the left iliac region was explored and a search was made for the femoral nerve by an abdominal surgeon. Although the femoral vessels were demonstrated, no trace of the nerve was found and it was assumed that a portion was missing. The wound failed to heal completely and on October 11, three sinus tracks in it were excised along with fragments of bone curetted from the left ilium. The wound then healed, except for a small area which united by secondary intention.

History of peripheral nerve injury. — From the moment of wounding there was paralysis of the muscles on the anterior aspect of the left thigh, with inability to extend the leg or the thigh. On getting up from bed in England he used crutches. Then he discovered that he could not walk without falling because his knee buckled underneath him whenever he stood alone or took a step. He could walk, after a fashion, with the help of a cane. He manufactured a splint for himself which prevented his knee from bending. Walking without a brace, he swung his hip around in external rotation and forward flinging of his hip. When stabilized, he then transferred the body weight to the weak leg and moved the good (R) leg forward. He was unable to walk upstairs without the brace.

When seen in the Peripheral Nerve Clinic, there was a small penetrating wound scar in the iliac region behind the left anterior superior spine, approximately 10 mm. below the left iliac crest. There was fair power in the ilio-psoas and adductor muscles, but no power in the muscles supplied by femoral nerve. There was marked atrophy of the whole leg, especially the anterior part of the thigh. Measurements of the thigh were as follows:

	Right	*Left*
Thigh	42.0 cm.	32.0 cm.
Mid calf	28.5 cm.	25.0 cm.

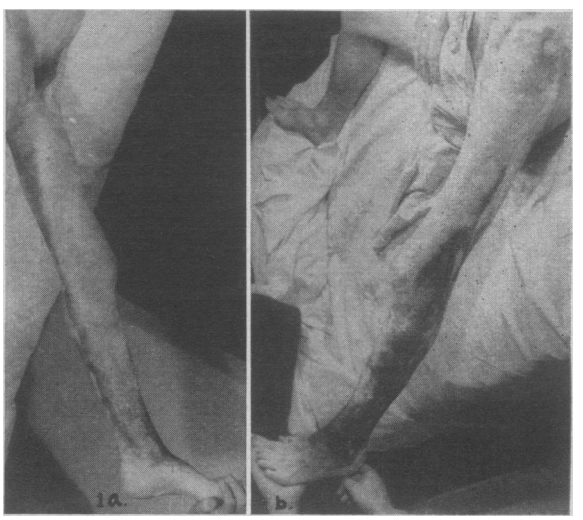
There was a mild flexion deformity of the knee due to overaction of the posterior thigh group muscles. This deformity was correctable by a detachable brace with an adjustable knee splint, which he wore regularly. The knee jerk was absent. There was gross quadriceps wasting and the other muscles of the thigh and hip were wasted from disuse. In knee flexion, the patella tended to slip down, interfering with complete flexion of the joint.

* This might represent an example of complete transient paralysis of an extremity in a high lesion of a nerve trunk as described by Livingstone.[7]

The sweating pictures (Figs. 1a and 1b) were made after the chinizarin-disulphonic acid sweating test was done as outlined by the technique of Gutman (absence of sweating in the feet in this patient is felt to be an artefact). The sweating dermatome as shown corresponds to the sensory pattern, but it is within the outer limits of the abnormal-normal pin prick barrier. There appears to be a slight amount of sweating below the knee which may be due to sympathetic components from the sciatic nerve contributing to the infra-patellar plexus.

OPERATIVE FINDINGS

A curvilinear incision was made 1" above and parallel to Poupart's ligament; the lower end being sharply deflected in vertical direction downwards just external to the femoral artery and crossing Poupart's ligament at



Figs. 1a and 1b.—Medial and lateral pictures after sweating test showing abnormality before operation.

this point. Above Poupart's ligament the muscles were split in the line of their fibres except the transversus which was divided obliquely at its upper end. Poupart's ligament was left intact but the vertical arm of the incision was deepened to expose clearly the femoral artery for its full length in Scarpa's triangle. The whole lateral flap of skin was dissected back giving free access to both thigh and the extra peritoneal space.

There was a large amount of scar tissue which at first prevented the identification of structures around Poupart's ligament including the femoral artery which we wished to use as a landmark. However, eventually we were able to identify this and following it upwards, lifting the peritoneum as we went, it eventually led close to the upper end of the femoral nerve as it made its exit from behind the psoas muscle. Similarly following the femoral artery downwards it was possible to pick up branches of the femoral nerve which when traced upwards led to the divided nerve.

Mobilization.—By lifting the psoas from the iliacus it was possible to trace the femoral to its origin from the vertebra and, somewhat at variance from the usual description, it remained as a complete nerve almost to the emergence of its roots. This allowed a very large amount of free play. Similarly below, by dissecting out the various branches considerable relaxation was obtained.

Two large neuromata lying directly in the missile path were seen opposite the crest of the ilium. The measurements of the neuromata were as follows: Femoral nerve above the level of the lesion; width ½", diameter ½". Proximal neuroma; length 1", width ⅝", depth

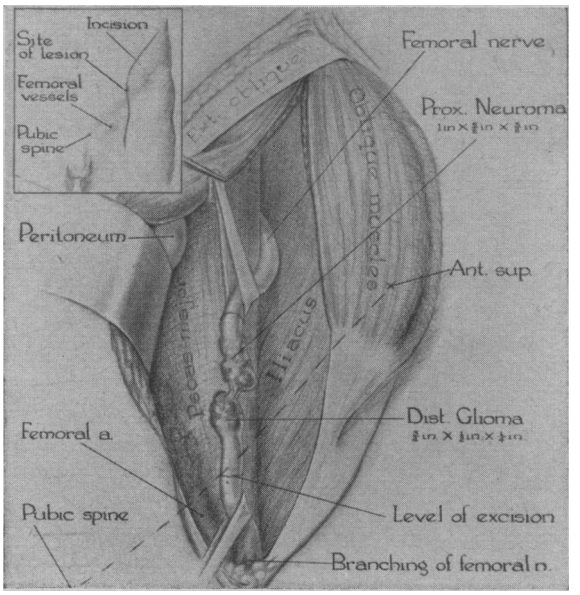


Fig. 2.—To show operative incision, muscle-splitting approach, extra peritoneal exposure of left femoral nerve from its emergence between psoas and iliacus to break up in the upper thigh.

⅜". Distal neuroma; length ¾", width ½", depth ¼". Femoral nerve below the level of the lesion; width ¼", diameter ⅝".

The lower neuroma had been driven inwards and there was a fibrous gap between the two ends as seen in the operative photographs and sketches.

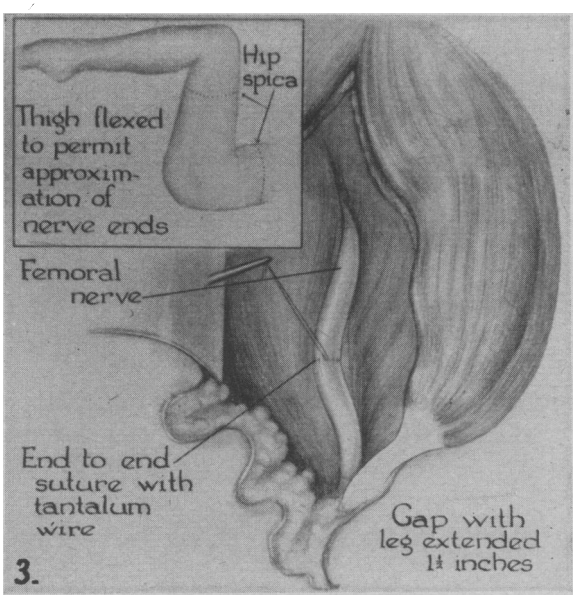


Fig. 3.—To show end to end suture and position of limb in order to obtain suture.

The proximal neuroma was excised and slices were cut back in the nerve until relatively normal pattern was obtained. The distal glioma was then excised, slicing was carried down the nerve until relatively normal nerve pattern was obtained. It was felt, however, that there was still some firmness in the distal end. after excision of the neuromata, a gap of 1½" remained. The proximal and distal ends of the nerve were then mobilized. The proximal end was visualized up to the transverse process of the lumbar vertebra and the low junction of the femoral nerve as described in text books was not seen in this instance. The distal nerve was then mobilized and the division in the femoral nerve in this case was seen to occur below Poupart's ligament rather than at the level of the ligament.

A sling suture was then put through both ends of the nerve and the leg was placed so that an end-to-end suture could be done. Eight small tantalum sutures were put through the perineurium with two guide silk sutures. Two identifying sutures were placed in the nerve at distances of 1" above and below the suture line. Tantalum foil was not put around the nerve suture because of the difficulty of removal. Satisfactory end-to-end suture was done and even with the leg flexed for about 60° there was still some slack in the nerve. However, the thigh was flexed at 90° on the body to make the suture safe.

The muscular closure was accomplished in layers using inverted silk sutures. The skin was closed with a continuous catgut shoemaker's stitch. The limb was flexed on the thigh continuously while this closure was carried out and then immobilized in a plaster hip spica. This overcame the unbalanced overaction and contracture of the posterior thigh muscles. The wound healed primarily. At three weeks the spica was divided and a turn-buckle was inserted, the thigh being extended 1 cm. daily thereafter.

FOLLOW UP

Motor studies.—January 29, 1947. Electromyogram showed definite reduction from continuous fibrillation to transient fibrillation in the rectus femoris.

February 5, 1947. Repeat electromyogram of rectus femoris before and after prostigmine revealed complete silence and was accepted as early evidence of partial neurotization.

August, 1947. Slight upward movement of the patella was visible although the patient had a "muscular feeling" that recovery was occurring before this.

November, 1947. Motor movements became increasingly stronger in quadriceps and electromyogram had gone on to definite polyphasic units.

Sensory studies.—First sensory recovery was noted in March, 1947, with the appearance of paræsthesia along the inner aspect of the upper thigh. In April, 1947, this paræsthesia had spread along the lateral and superior aspects of the anterior thigh. In June, 1947, the entire anterior aspect of the thigh had become paræsthetic. This abnormal feeling spread down the leg and in turn was replaced in the thigh by hypalgesia. In October, 1947, the entire thigh was hypalgesic except for a small area around the patella. In December, even the patellar area showed improvement to hypalgesia. The patient has since gone to work in a garage where he is actively employed.

Patient was last seen October, 1948, when sensation had returned over the whole of the femoral nerve distribution but pin prick still evoked a "tingling" response. There was active movement in the quadriceps. The knee jerk had not returned, although there was a "flicker" response obtained in upper part of thigh muscles on tapping the patellar tendon. The patient still wore his brace at work but discarded it each day after work. He had grown careless in his quadriceps exercises but the recovery present suggested that with rigorous retraining he could develop his thigh muscles and eventually do away with his brace.

DISCUSSION

We have felt obliged to record this femoral nerve case in detail since it has proved to be a remediable lesion. We did not at first think so. Based on our series, there must be one femoral nerve injury in each 500 war injuries of peripheral nerves where abdominal wounds are well-handled. This nerve, though sutured two years after injury, has obtained satisfactory recovery. (It is to be noted that the patient had a partial sciatic lesion after operation due to over rigorous stretching of a knee contracture in the hip spica.)

SUMMARY

1. Few detailed experiences of femoral nerve injuries are recorded.

2. Femoral nerve injuries are to be expected in lower abdominal missile wounds; and the experience in World War II has demonstrated that these wounds are not necessarily fatal.

3. Femoral nerve suture may not be possible as early as in other peripheral nerve injuries, but recovery can be expected, even though delay is as long as two years after operation.

4. Rehabilitation and tension (quadriceps) exercises are especially important during the recovery phase so that the patient may not become "wedded" to his brace and allow femoral muscles to develop disuse atrophy.

REFERENCES

1. POLLOCK, L. T. AND DAVIS, L.: Peripheral Nerve Injuries, H. B. Hoeber, New York, 1933.
2. STOOKEY, B. D.: Surgical and Mechanical Treatment of Peripheral Nerve Injuries, W. B. Saunders, Philadelphia, 1922.
3. BENISTY, A.: The Clinical Forms of Nerve Lesions, University London Press, 1918.
4. GURDJIAN, E. S.: *J. Michigan Med.*, **30**: 508, 1931.
5. HAYMAKER, W. E. AND WOODHALL, B.: Peripheral Nerve Injuries, W. B. Saunders, Philadelphia, 1945.
6. TINEL, J.: Nerve Wounds, Wm. Wood, New York, 1917.
7. LIVINGSTON, W. K.: Pain Mechanism, Macmillan & Co., New York, 1942.

GLOMUS TUMOURS

Harold Gold, M.D.

Departments of Pathology, University of Toronto and Toronto General Hospital, Toronto, Ont.

THIS paper is based on a review of 24 cases of glomus tumours which are on file in the surgical pathological laboratory of the Toronto General Hospital.

These tumours were probably first recognized in 1812 when William Wood presented five cases of painful subcutaneous nodules.[12] Later authors recorded them as angiosarcoma, perithelioma, and fibromyomatous angioma.[6, 23] Sucquet, in 1862, outlined the arterio-venous anastomosis, while Hoyer's[13] description in 1877 was more detailed. In 1920 Barre recognized the clinical entity, and Masson, in 1924, published a report of Barre's cases and one of his own.[20, 26] Masson called these entities "neuro-myo-arterial glomus tumours" (glomus —a conglomeration or plexus of minute arteries and veins).[20]

Most authors find an equal sex incidence,[4, 9, 13] but, in the present series, the male cases more than doubled the female ones. There is a wide range in the age group, while symptoms may range in duration from months up to years. Geographic and racial characteristics are not remarkable. The tumours are most frequently located on the ventral surfaces of the hands and feet, the tips of the digits, including the nail beds, the thenar and hypothenar eminences, and the palmar surfaces of the first three phalanges.[11, 17, 22, 24] The present group exhibits a fairly wide distribution, being most often encountered in the upper extremities. Trauma has sometimes been incriminated as an antecedent factor in the production of these tumours, but a history of this was obtained in only two of the cases (Table I).

Sections of glomus bodies and tumours were studied under various staining procedures, including hæmatoxylin and eosin, phosphotungstic acid hæmatoxylin, Masson's connective tissue stain, Verhoeff's stain for elastic tissue, Laidlaw's silver stain for reticulum, and Bodian and Gross-Bielschowsky stains for nerve fibrils.

GLOMUS BODIES

To adequately understand the glomus tumours one should have a clear acquaintance